What is claimed:

1. A method for fabricating a membrane for use in a fuel cell membrane electrode assembly comprising the steps of:

(A) preparing a solid electrolyte membrane, wherein the membrane has an eventual anode side and an eventual cathode side; and

(B) twin-wire arc-depositing at least one catalyst onto at least one of the eventual anode side and the eventual cathode side of said solid electrolyte membrane.

2. The method of claim 1, wherein said twin-wire arc depositing of said catalyst results in a deposited catalyst weight from about 0.05 mg of catalyst per square centimeter of said electrolyte membrane to about 1.0 mg of catalyst per square centimeter of said electrolyte membrane.

3. The method of claim 1, wherein said catalyst is twin-wire arc-deposited to the eventual anode side of said electrolyte membrane and said catalyst is twin-wire arc-deposited to the eventual cathode side of said electrolyte membrane.

4. The method of claim 1, wherein said step of preparing a solid electrolyte membrane comprises twin-wire arc depositing a porous solid layer to a solid substrate.

5. The method of claim 1, wherein said twin-wire arc depositing step comprises depositing a nano-structured catalyst coating onto said membrane from a precursor catalyst material selected from the group consisting of a metal, metal alloy, metal compound, and ceramic material, said step comprising the sub-steps of:

(a) providing an ionized arc nozzle means comprising two consumable electrodes in an elongate rod or wire form and a working gas flow to form an ionized arc between said two consumable electrodes, wherein said consumable electrodes provide said precursor catalyst material vaporizable therefrom by said ionized arc;

(b) operating said arc nozzle means to heat and at least partially vaporize said precursor catalyst material for providing a stream of nanometer-sized vapor clusters of said

precursor catalyst material into a chamber in which said membrane is disposed; and

(c) introducing a stream of a carrier gas into said chamber to impinge upon said stream of precursor vapor clusters to produce depositable nano clusters which are carried by said carrier gas to deposit onto a first side of said membrane for forming said nano-structured catalyst coating.

6. The method of claim **5**, wherein said carrier gas comprises a reactive gas that reacts with said precursor vapor clusters for producing said depositable nano clusters which are metal compounds or ceramic materials.

7. The method as set forth in claim **5**, further comprising a sub-step of operating at least a second ionized arc nozzle means to completely vaporize said precursor catalyst material.

8. The method as set forth in claim **5**, wherein said precursor material comprises at least one transition metal element selected from the group consisting of Groups IB, IIB, IIIB, IVB, VB, VIB, VIIB, and VIII elements of the Periodic Table of Elements, wherein said Group IB includes Cu, Ag, and Au; Group IIB includes Zn, Cd, and Hg; Group IIIB includes Sc, Y, and La, Group IVB includes Ti, Zr, and Hf; Group VB includes V, Nb, and Ta; Group VIB includes Co, Mo, W; Group VIIB includes Mn and Re; and Group VIII includes Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, and Pt.

9. The method as set forth in claim **6**, wherein said stream of reactive gas comprises a gas selected from the group consisting of hydrogen, oxygen, carbon, nitrogen, chlorine, fluorine, boron, sulfur, phosphorus, selenium, tellurium, arsenic vapor and combinations thereof.

10. The method as set forth in claim **5**, wherein said carrier gas comprises an inert gas.

11. The method as set forth in claim **5**, wherein said membrane comprises a train of individual pieces of solid electrolyte membrane material being moved sequentially or concurrently into said chamber and then moved out of said chamber after said coating is formed.

12. The method as set forth in claim **1**, wherein said membrane comprises an oxide structure that is ion-conducting.

13. The method as set forth in claim **1**, wherein said solid electrolyte membrane comprises an ion exchange polymer that is ion-conducting.

14. The method as set forth in claim **5**, wherein said precursor material comprises an alloy of at least two metallic elements.

15. The method as set forth in claim **5**, wherein said stream of carrier gas contains a reactive gas that reacts with said precursor catalyst vapor clusters in such a manner that the reaction heat released is used to sustain the reaction until most of said precursor vapor clusters are substantially converted to nanometer-sized metal compound or ceramic clusters.

16. The method as set forth in claim **5**, wherein said stream of carrier gas is pre-heated to a predetermined temperature prior to being injected to impinge upon said precursor vapor clusters.

17. The method as defined in claim **5**, wherein the step of operating an arc nozzle means to heat and at least partially vaporize the precursor catalyst material to form a stream of precursor catalyst vapor clusters includes the sub-steps of melting the precursor catalyst material and atomizing the resulting metal melt to form nanometer-scaled liquid droplets of said precursor material, said liquid droplets becoming mixed with said stream of vapor clusters.

18. The method as defined in claim **17**, wherein said liquid droplets react with said reactive gas to form nano-scaled metal compound or ceramic clusters.

19. The method of claim **1**, wherein a first catalyst is deposited on the eventual anode side of the electrolyte membrane and a second catalyst is deposited on the eventual cathode side of the electrolyte membrane, and the first catalyst differs from the second catalyst.

20. A method for forming an electrode for use in a fuel cell membrane electrode assembly comprising the steps of:

(A) preparing a precursor material to a catalyst, said precursor catalyst material being in an elongate rod or wire form;

(B) preparing a backing that includes multiple sides; and

(C) twin-wire arc-depositing said catalyst onto said multiple sides of said backing.

21. The method of claim **20**, wherein said backing comprises carbon paper or carbon cloth.

22. The method of claim **20**, wherein said twin-wire arc depositing of said catalyst results in a deposited catalyst weight from about 0.05 mg of catalyst per square centimeter of said backing to about 1.0 mg of catalyst per square centimeter of said backing.

23. The method of claim **20**, wherein said catalyst is deposited to an anode electrode, a cathode electrode, or both.

24. The method of claim **20**, wherein said step of preparing a backing comprises twin-wire arc depositing a porous solid layer onto a solid substrate.

25. The method of claim **20**, wherein said twin-wire arc depositing step comprises depositing a nano-structured catalyst coating onto said backing from a precursor catalyst material selected from the group consisting of a metal, metal alloy, metal compound, and ceramic material, said step comprising the sub-steps of:

(a) providing an ionized arc nozzle means comprising two consumable electrodes in an elongate rod or wire form and a working gas flow to form an ionized arc between said two consumable electrodes, wherein said consumable electrodes provide said precursor catalyst material vaporizable therefrom by said ionized arc;

(b) operating said arc nozzle means to heat and at least partially vaporize said precursor catalyst material for providing a stream of nanometer-sized vapor clusters of said precursor catalyst material into a chamber in which said backing is disposed; and

(c) introducing a stream of a carrier gas into said chamber to impinge upon said stream of precursor vapor clusters to produce depositable nano clusters which are carried by said carrier gas to deposit onto a first side of said backing for forming said nano-structured catalyst coating.

26. The method of claim **25**, wherein said carrier gas comprises a reactive gas that reacts with said precursor vapor clusters for producing said depositable nano clusters which are metal compounds or ceramic materials.

27. The method as set forth in claim **25**, further comprising a sub-step of operating at least a second ionized arc nozzle means to completely vaporize said precursor catalyst material.

28. The method as set forth in claim **25**, wherein said precursor material comprises at least one transition metal element selected from the group consisting of Groups IB, IIB, IIIB, IVB, VB, VIB, VIIB, and VIII elements of the Periodic Table of Elements, wherein said Group IB includes Cu, Ag, and Au; Group IIB includes Zn, Cd, and Hg; Group IIIB includes Sc, Y, and La, Group IVB includes Ti, Zr, and Hf; Group VB includes V, Nb, and Ta; Group VIB includes Co, Mo, W; Group VIIB includes Mn and Re; and Group VIII includes Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, and Pt.

29. The method as set forth in claim **26**, wherein said stream of reactive gas comprises a gas selected from the group consisting of hydrogen, oxygen, carbon, nitrogen, chlorine, fluorine, boron, sulfur, phosphorus, selenium, tellurium, arsenic vapor and combinations thereof.

30. A fuel cell comprising:

(A) an anode electrode;

(B) a cathode electrode;

(C) a fuel supply; and

(D) an electrolyte membrane comprising a solid electrolyte, wherein said membrane has a first side adjacent the anode electrode and a second side adjacent the cathode electrode, and wherein said electrolyte membrane further comprises a twin-wire arc-deposited

catalyst on at least one of the first and second sides thereof, said twin-wire arc-deposited catalyst having a porosity effective for sustaining a voltage and gas flow across a membrane electrode assembly in said fuel cell.

31. The fuel cell of claim **30**, wherein said twin-wire arc-deposited catalyst weight is from about 0.05 mg of catalyst per square centimeter of said electrolyte membrane to about 1.0 mg of catalyst per square centimeter of said electrolyte membrane.

32. The fuel cell of claim **30**, wherein said catalyst is twin-wire arc-deposited to the first side, the second side or both sides of said electrolyte membrane.

33. The fuel cell of claim **30**, wherein said catalyst comprises a transition metal.

34. The fuel cell of claim **30**, wherein said catalyst is selected from the group consisting of Pt, Ru, Ni, Ti, Zr, Sn, SnO_2, Os, Ir, W, WO_3, and Re.

35. The fuel cell of claim **30**, wherein said catalyst further comprises two or more catalysts.

36. The fuel cell of claim **30**, wherein said fuel cell comprises a methanol fuel cell.

37. The fuel cell of claim **30**, wherein said fuel cell comprises a hydrogen fuel cell.

38. The fuel cell of claim **30**, wherein said fuel cell comprises a solid-oxide fuel cell.

39. A method for making a membrane electrode assembly, comprising:

(A) preparing a polymer electrolyte membrane, wherein the membrane has an eventual anode side and an eventual cathode side;

(B) twin-wire arc-depositing at least one catalyst onto at least one of the eventual anode side and the eventual cathode side of said electrolyte membrane; and

(C) bonding an anode to the eventual anode side of the membrane and a cathode to the

eventual cathode side of the membrane.

40. The method of claim **39**, wherein at least one of the anode and the cathode are made by:
obtaining a catalyst;
obtaining a backing; and
twin-wire arc-depositing said catalyst onto said backing.

41. The method of claim **39**, wherein a first catalyst is twin-arc-deposited on the eventual anode side of the electrolyte membrane and a second catalyst is twin-arc-deposited on the eventual cathode side of the electrolyte membrane, and the first catalyst differs from the second catalyst.

42. The method of claim **5**, wherein the step of preparing a membrane comprises feeding a segment of a membrane into said chamber from a feeding roll of said membrane positioned on one side of said chamber.

43. The method of claim **42**, further comprising a post-deposition step of taking up said catalyst-deposited membrane using a winding roller positioned on another side of said chamber.

44. The method of claim **20**, wherein the step of preparing a backing comprises feeding a segment of a backing layer into said chamber from a feeding roll of said backing layer positioned on one side of said chamber.

45. The method of claim **44**, further comprising a post-deposition step of taking up said catalyst-deposited backing using a winding roller positioned on another side of said chamber.

46. The method of claim **39**, wherein the step of preparing a polymer electrolyte membrane comprises feeding a segment of a polymer electrolyte membrane into said chamber from a feeding roll of said membrane positioned on one side of said chamber.

47. The method of claim **46**, further comprising a post-deposition step of taking up said catalyst-

deposited membrane using a winding roller positioned on another side of said chamber.

48. A fuel cell comprising:

(A) an anode electrode;

(B) a cathode electrode;

(C) a fuel supply; and

(D) an electrolyte membrane comprising a solid electrolyte, wherein said membrane has a first side adjacent the anode electrode and a second side adjacent the cathode electrode;

wherein at least one of said anode electrode and cathode electrode comprises a twin-wire arc-deposited catalyst, said twin-wire arc-deposited catalyst having a porosity effective for sustaining a gas flow across said at least one electrode in said fuel cell.

49. An integrated method for making a fuel cell structure, comprising:

(A) feeding a polymer electrolyte membrane from a membrane source into a twin-wire arc deposition chamber continuously or intermittently on demand, wherein the membrane has an eventual anode side and an eventual cathode side;

(B) twin-wire arc-depositing at least one catalyst onto at least one of the eventual anode side and the eventual cathode side of said electrolyte membrane;

(C) feeding and bonding an anode to the eventual anode side of the membrane and a cathode to the eventual cathode side of the membrane to form a basic fuel cell structure; and

(D) collecting said basic fuel cell structure on a collector means.

50. The method of claim **49**, wherein said membrane source and said collector means comprise a driving roller.

51. The method of claim **49**, wherein step (B) comprises twin-wire arc-depositing one catalyst layer onto the eventual anode side and another catalyst layer to the eventual cathode side of said electrolyte membrane.